invention, a disk drive has a read element including a high resistance soft magnetic layer disposed between at least one insulating layer and a magnetic shield.

[0017] Referring to **FIG. 1**, a magnetic disk drive **100** has at least one rotatable magnetic disk **102** supported by a spindle **104** and rotated by a motor (not shown). There is at least one slider **106** with an attached recording head **108** positioned over the disk **102** surface while reading and writing. The recording head **108** includes a write element for writing data onto the disk **102**. The recording head also includes a magnetoresistive sensor according to the present invention (shown in detail below) used as a read element for reading data from the disk. The magnetoresistive sensor is responsive to an external magnetic field such as the field from a written transition on the magnetic disk **102**. The slider **106** is attached to a suspension **110** and the suspension **110** is attached to an actuator **112**. The actuator **112** is pivotally attached **114** to the housing **116** of the disk drive **100** and is pivoted by a voice coil motor **118**. As the disk rotates, the actuator **112** positions the slider **106** along with the suspension **110** along a radial arcuate path **120** over the disk **102** surface to access a data track of interest.

[0018] Again referring to **FIG. 1**, during operation of the disk drive **100**, the motion of the rotating disk **102** relative to the slider **106** generates an air bearing between the slider **106** and the disk **102** which exerts an upward force on the slider **106**. This upward force is balanced by a spring force from the suspension **110** urging the slider **106** toward the surface of the disk **102**. Alternatively, the slider **106** may be in either partial or continuous contact with the disk **102** surface during operation.

[0019] **FIG. 2** illustrates a more detailed view of a slider **200**. The recording head **220** is typically constructed on the trailing surface **202** of the slider **200**. **FIG. 2** illustrates the upper pole **204** and the turns **206** of the coil **208** of the write element **210** of the recording head **220**. The read sensor **212** is disposed between the slider **200** and the write element **210**. The most active portion of the read sensor **212** is revealed on the disk facing surface **215** of the slider **200**. The read sensor **212** is also disposed between two magnetic shields **214**. The magnetic shields **214** are typically formed from a nickel-iron alloy. The magnetic shields **214**, the read sensor **212**, and any intervening layers comprise the read element **216**. The electrical connection pads **218** which allow connection with the write element **210** and read element **216** are illustrated.

[0020] **FIG. 3** illustrates an enlarged view of a read element **300** according to the prior art. The multiple layers in the sensor stack **302** are typically abutted with magnetic hard bias and lead structures **304**. The sensor stack **302** is disposed between two magnetic shields **306**. There are two insulating layers **308**, typically formed from alumina, silicon oxide, silicon nitride, tantalum oxide, or the like, which insulate the sensor stack **302** from each of the magnetic shields **306**. The magnetic read gap **310** is the distance between the two magnetic shields **306** in the vicinity of the sensor stack **302**. As mentioned previously, in order to support higher recorded densities, the read gap **310** must be reduced. The sensor stack **302** cannot be significantly reduced in thickness without degrading sensor performance. Therefore, the thickness of the insulating layers **308** have been progressively reduced. A typical thickness of an insulating layer is less than 200 Angstroms and in the near future will be required to become much thinner. However the insulating layers **308** are now so thin that uniformity, susceptibility to minor defects, and the ability to withstand electrostatic damage are becoming significant problems.

[0021] **FIG. 4***a* illustrates an embodiment of a read element **400** according to the present invention. The read element **400** includes a sensor stack **402** with abutted hard bias and lead structures **404**. The sensor stack **402** is disposed between two magnetic shields **405**, **406** and there are insulating layers **407**, **408** disposed between the sensor stack **402** and the magnetic shields **405**, **406**. The insulating layers **407**, **408** are typically formed from alumina, silicon oxide, silicon nitride, tantalum oxide, or the like. The magnetic shields **405**, **406** are typically formed from a nickel-iron alloy such as permalloy. The read element **400** includes two layers **414**, **415** of high resistance soft magnetic material disposed between each of the insulating layers **407**, **408** and the magnetic shields **405**, **406**.

[0022] **FIG. 4***b* illustrates another embodiment of the present invention. The read element **400** includes a sensor stack **402** with abutted hard bias and lead structures **404**. The sensor stack **402** is disposed between two magnetic shields **405**, **406** and there are insulating layers **407**, **408** disposed between the sensor stack **402** and each of the magnetic shields **405**, **406**. The read element **400** includes a layer **414** of high resistance soft magnetic material disposed between the bottom insulating layer **407** and the bottom magnetic shield **405**.

[0023] **FIG. 4***c* illustrates a third embodiment of the present invention. The read element **400** includes a sensor stack **402** with abutted hard bias and lead structures **404**. The sensor stack **402** is disposed between two magnetic shields **405**, **406** and there are insulating layers **407**, **408** disposed between the sensor stack **402** and each of the magnetic shields **405**, **406**. The read element **400** includes a layer **415** of high resistance soft magnetic material disposed between the top insulating layer **408** and the top magnetic shield **406**.

[0024] Preferably, the resistivity of the high resistance soft magnetic material is high enough to significantly retard current through the material. The resistivity is preferably greater than about 2000 micro-ohm-cm. In addition, the magnetic moment of the high resistance soft magnetic material is preferably high enough such that the material functions as a magnetic shield without magnetically saturating. The magnetic moment of the high resistance soft magnetic material is preferably greater than about 80 emu/cc. The material preferably has a permeability greater than about 200 to function well as a magnetic shield. Finally, the high resistance magnetic material should be magnetically soft preferably having a coercivity less than about 10 Oe.

[0025] There are several materials which meet these criterion. The composition of effective materials is conveniently represented by A-B-C where A is selected from the group of iron (Fe) and cobalt (Co), B is selected from the group of hafnium (Hf), yttrium (Y), tantalum (Ta) and zirconium (Zr), and C is selected from the group of oxygen (O) and nitrogen (N). Cobalt-iron-hafnium-oxygen (CoFeHfO) is also suitable. FeHfN is particularly suitable since the magnetic moment of FeHfN is higher than the moment of the conductive magnetic shields (**405**, **406** in **FIGS. 4***a*, **4***b* and **4***c*). The magnetic shields are typically formed from